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Effects of Several Different Food Plants on Nymphal Development of *Palomena angulosa* MOTSCHULSKY (Hemiptera : Pentatomidae) [1)]

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Summary

Kidney bean fruits, pea fruits, wheat ears, hogweed fruits and lilac fruits were suitable food plants for the nymphal development of *Palomena angulosa* MOTSCHULSKY. Fruits of asparagus and *Sorbus commixta* were very good food at least for younger nymphs and perhaps older nymphs in the field. Younger and succulent rape fruits may be also a suitable food for nymphal growth. Cruciferous plants, potato plants, alfalfa and sugar beet plants each without seeds or fruits could not support growth throughout the nymphal period.

Introduction

There have been a number of investigations on food plants of various heteropterous insects. *Palomena angulosa* MOTSCHULSKY (Hemiptera: Pentatomidae) is known as a polyphagous insect which feeds on various plants and plant parts (KOBAYASHI, 1959; HASEGAWA, 1958, 1960; KAWASAWA and KAWAMURA, 1977). KUGELBERG (1977a) reported that females of the seed-feeding bug *Lygaeus equestris* often laid their eggs on places so far from possible food plants for their offsprings that the nymphs were faced with difficulty in reaching their food plant. Therefore, the bugs must adapt in various manners for keeping pace with food resource both in time and in distribution: polyphagous habit, synchronization of life-cycle with food occurrence and well-developed food-localizing ability (KUGELBERG, 1977b). *P. angulosa* is similar to this lygaeid bug; in many cases, nymphal *P. angulosa* seems to have to grow by alternating food plants from one to another in the field. It is important for elucidation of its bionomics, therefore, to learn the value of various food plants for nymphal growth. Little has been known on food plants supporting the nymphal growth, except the information reported by KOBAYASHI (1971), who was successful in rearing *P. angulosa* from egg to adult with various beans. In the present study, we investigated whether several other plants and plant parts can or cannot support the nymphal development.

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Materials and Methods

Insects used. Adults after hibernation were collected from willow and lilac trees in June. They were put in plastic cages with food plants and a sheet of filter paper each at the top and the bottom for oviposition site. Eggs laid were removed into petri-dishes with a sheet of filter paper at the bottom every day and kept until hatching under room condition. The first instar nymphs which hatched from the eggs were kept there without food till the 2nd instar. The 2nd instar nymphs one day after moulting were used for experiments.

Food plants and plant parts used. In 1983, the following seven plants and their mixture were used for experiments: (1) flower buds of yellow cress, (2) flower buds (alone or including leaves and young stems) of potato plants till August 15, leaves including petioles till September 4 and thereafter fruits of nightshade, (3) flower parts of alfalfa till September 7 and then its young seeds, (4) young leaves of sugar beets, (5) flower parts of hog-weed till August 15 and thereafter its young fruits, (6) fruits of kidney beans, (7) ears of wheat newly collected till August 16 and then those kept in a refrigerator, and (8) various mixtures of the above.

In 1984, the following seven plant parts were supplied for the nymphs: (1) fruits of lilac, (2) fruits of rape till August 21 and thereafter fruits of kidney beans, (3) fruits of asparagus, (4) fruits of *Sorbus commixta*, (5) fruits of pea, (6) fruits of *Malus sieboldii*, and (7) fruits of *Malus micromalus*.

Rearing methods. In 1983, nymphs were reared individually and in a group. In the individual test, a nymph was put in a plastic petri-dish (9 cm) with respective food plants (exchanged with a new one every other day). A sheet of filter paper was laid on the bottom and moistened by distilled water (0.2 m*l*/day). The test was repeated 20 times. In the group test, 20 nymphs were placed in a plastic cage (11.4 in height, 17.7 cm in diameter) with each food. Both tests were carried out under room condition (22 to 30°C and natural day-length). The experiments were started on July 3.

In 1984, 15 nymphs were put in each of the plastic petri-dishes (9 cm) containing each food (refreshed every second day). They were reared in an incubator set at a variable temperature (27°C for 8 hr and 23°C for 16 hr) and in natural day-length. The experiment was begun on July 23.

Results and Discussion

Experiments in 1983

Survival rate. Figs. 1 and 2 show the survival rates of nymphs fed several different food plants after the beginning of the experiment. In the individual test, the nymphs fed sugar beet leaves all died in the 2nd instar (before 30 days after the start of the experiment). The nymphs reared with yellow cress flower buds all died before the early days of 3rd instar (24 days), while 70% of those supplied with alfalfa grew to the last days of 3rd instar (37 days) but all died in the 4th instar. The nymphs fed flower buds of potato plants all died by the time of the beginning of 3rd instar (17 days). Eighty percent of the nymphs reared with flower parts of hogweed died before the last days of 2nd instar (32 days) but 40% (5% in total) of the remaining nymphs fed on fruits after the 3rd instar grew to the adult stage. Fifty-five, 50 and 60% of the nymphs supplied respectively with ears of wheat, fruits of kidney bean and mixed foods could grow to the adult stage.

In the group test, the nymphs all died before the 3rd instar (21 days) when reared with sugar beet leaves and by the beginning of 3rd instar (22 days) when supplied with yellow cress flower buds. The nymphs fed on alfalfa

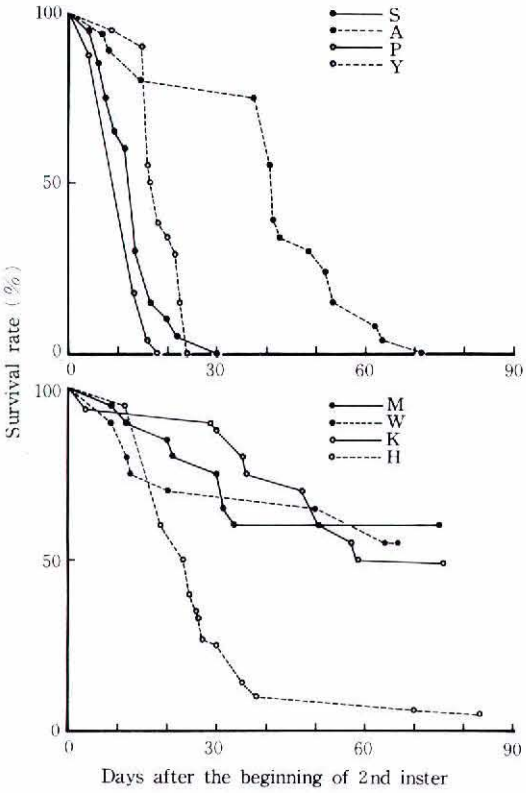

Fig. 1. Survival rate of *P. angulosa* nymphs fed several different food plants (individual test). S; sugar beet, A; alfalfa, P; potato, Y; yellow cress, W; wheat, K; kidney bean, H; hogweed, M; mixture (W, K, H).

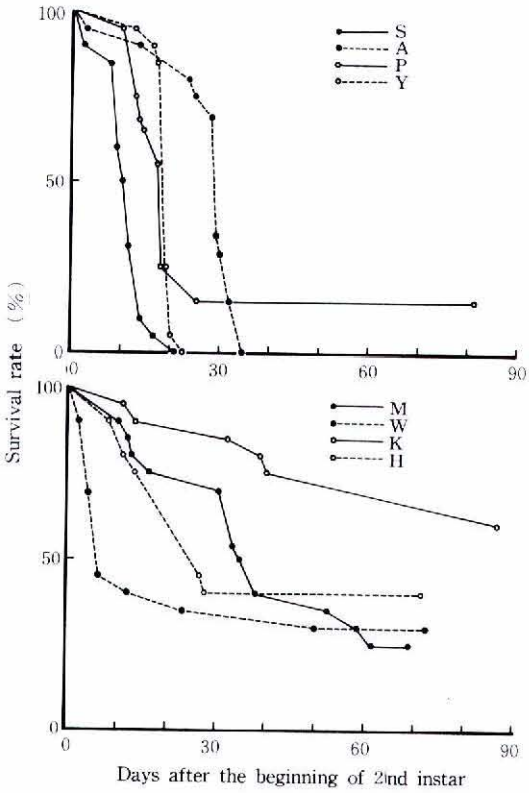

Fig. 2. Survival rate of *P. angulosa* nymphs fed several different food plants (group test).

all died within a few days after the start of 3rd instar (35 days), perhaps because of the outbreak of bacterial disease. Fifteen percent of the nymphs supplied with potato plants including leaves and stems could live till about 60 days after the start of the experiment and after that complete their growth by the help of nightshade fruits. Forty percent of the nymphs could grow to the adult stage when reared with flower parts of hogweed till the last days of 2nd instar and then with young fruits, 30% when fed wheat ears and 60% when fed kidney bean fruits. Twenty five percent of the nymphs fed on the mixture of these food plants grew to the adult stage.

Days required for development and weight gain. The results are shown in Figs. 3 and 4. The mean weight of the 2nd instar nymphs at the starting point of experiment was 1.6 mg. In the individual test, when fed wheat ears, the nymphs took 8.7 days on the average to get to the 3rd instar (7.0 mg in the mean weight at the beginning of the instar), 17.3 days to the 4th (21.7 mg), 30.0 days to the 5th (58.7 mg) and 58.7 days to the adult stage (129.3 mg). The nymphs fed on kidney bean fruits required a longer time to reach respective stages than those fed on wheat but gained about the same weight: 13.1 days to reach the 3rd instar (7.0 mg), 24.6 days to the 4th (20.3 mg), 38.4 days to the 5th (58.6 mg) and 67.4 days to the adult stage (125.2 mg).

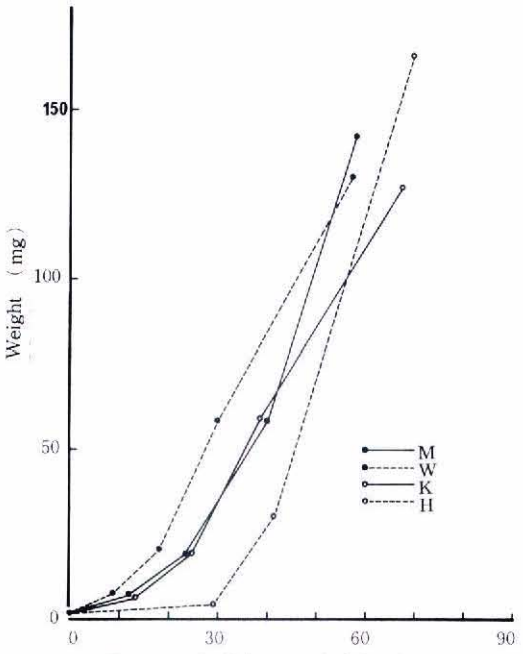

Fig. 3. Growth speed and weight gain of *P. angulosa* nymphs fed several different food plants. Circles show average turning points from one nymphal instar to another (individual test).

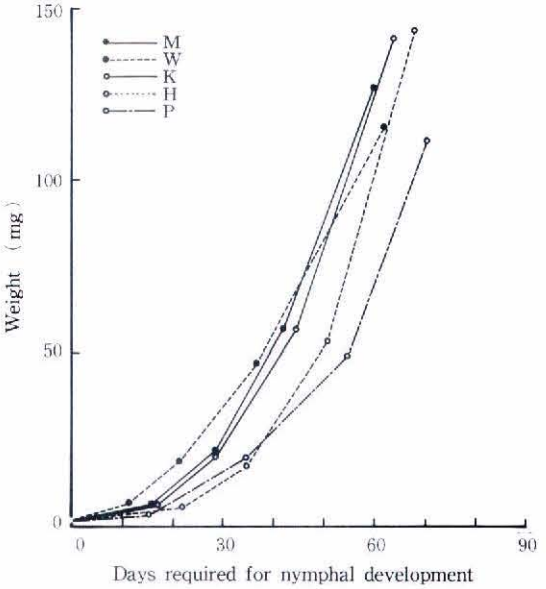

Fig. 4. Growth speed and weight gain of *P. angulosa* nymphs fed several different food plants (group test).

When reared with flower parts of hogweed till the 3rd instar (5.8 mg), the growth of nymphs was much delayed (28.3 days to the 3rd), but after the flower parts were replaced with the young fruits (since the 3rd instar), the growth recovered and the nymphs reached the 4th instar (30.6 mg) in 41.0 days, the 5th (65.4 mg) in 48.0 days and the adult stage (165.6 mg) in 70.0 days. The nymphs fed on the mixture of food plants required 11.9 days to reach the 3rd instar (6.9 mg), 23.8 days to the 4th (19.3 mg), 39.8 days to the 5th (58.5 mg) and 58.5 days to the adult stage (142.0 mg).

In the group test, the wheat-fed nymphs took 10.8 days to reach the 3rd instar (7.4 mg), 21.3 days to the 4th (19.0 mg), 36.2 days to the 5th (46.9 mg) and 62.3 days to the adult stage (114.2 mg). The kidney bean-fed nymphs reached the 3rd instar (6.3 mg) in 15.9 days, the 4th (20.6 mg) in 27.9 days, the 5th (56.7 mg) in 44.4 days and the adult stage (140.8 mg) in 64.1 days. When reared with flower parts and then with fruits of hogweed, the nymphs required 21.9 days to the 3rd instar (5.7 mg), 34.5 days to the 4th (17.2 mg), 50.9 days to the 5th (52.4 mg) and 68.3 days to the adult stage (142.4 mg). No significant differences in the days required for the growth and in the weight gain were found between the individual test and the group test of these three food plants. The nymphs fed stems, leaves and flowers of potato plants took 14.6 days to reach the 3rd instar (5.2 mg), 34 days to the 4th (19.8 mg), 54.3 days to the 5th (47.8 mg), being inferior in growth speed and weight gain to the nymphs fed wheat, kidney beans or hogweed. They grew quickly, however, after the food was changed from potato plant to fruits of nightshade and reached the adult stage (110.7 mg) in 70.6 days. The mixture-fed nymphs required 14.9 days to the 3rd instar (6.2 mg), 28.2 days

to the 4th (21.6 mg), 42.3 days to the 5th (57.0 mg) and 60.2 days to the adult stage (125.8 mg).

In both individual and group tests, the growth of the wheat-fed nymphs to the 5th instar was speedier than the mixture-fed ones. This may be due to the lesser ability of food selection in the younger nymphal stage; younger nymphs seem to feed less willingly on wheat ears than kidney beans etc.

KOBAYASHI (1971) succeeded in rearing *P. angulosa* from the 2nd instar to the adult stage with fruits of various beans and seeds of the common plantain. It the present study, it was found that kidney bean fruits, wheat ears and hogweed fruits were more suitable food plants for the nymphal development of *P. angulosa* and that any plants without seeds or fruits could not support the nymphal growth completely.

Experiment in 1984

Survival rate. The results are shown in Fig. 5. The nymphs reared with fruits of *Malus sieboldii* or *M. micromalus* all died before the last days of 2nd instar or the early days of 3rd instar. The nymphs which developed to the 5th instar amounted to 53.3% when fed fruits of asparagus and 73.3% when fed fruits of *Sorbus commixta*, but all of them died in the 5th instar. When fed on fruits of lilac, 46.7% of the nymphs grew to the 5th instar and all of them could develop to the adult stage. Eighty percent of the nymphs fed fruits of pea reached the 5th instar, but only 2 bugs (13.3%) could develop to the adult stage. The percentage of those nymphs reared with fruits of rape till August 21 (29 days after the start of experiment) and thereafter with fruits of kidney bean, which developed to the 5th instar, was 26.7, all of them could grow to the adult stage.

Days required for development. The results are shown in Fig. 6. For the lilac-fed nymphs it took 7.4 days on the average to develop to the 3rd instar, 16.1 days to the 4th, 30.4 days to the 5th and 43.9 days to the adult stage,

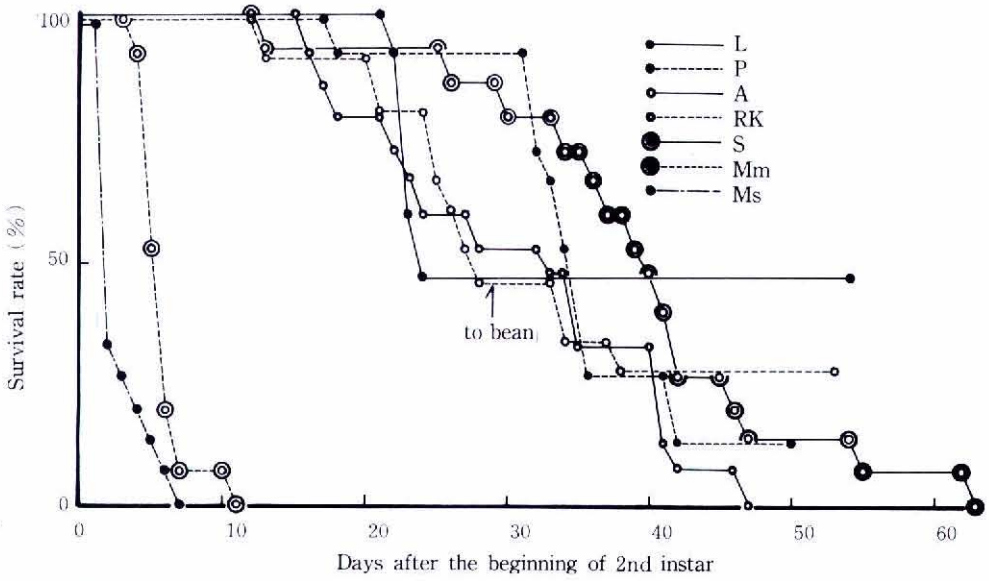

Fig. 5. Survival rate of *P. angulosa* nymphs fed several different food plants in 1984. L; lilac, P; pea, A; asparagus, RK; rape+kidney bean, S; *S. commixta*, Mm; *M. micromalus*, Ms; *M. sieboldii*.

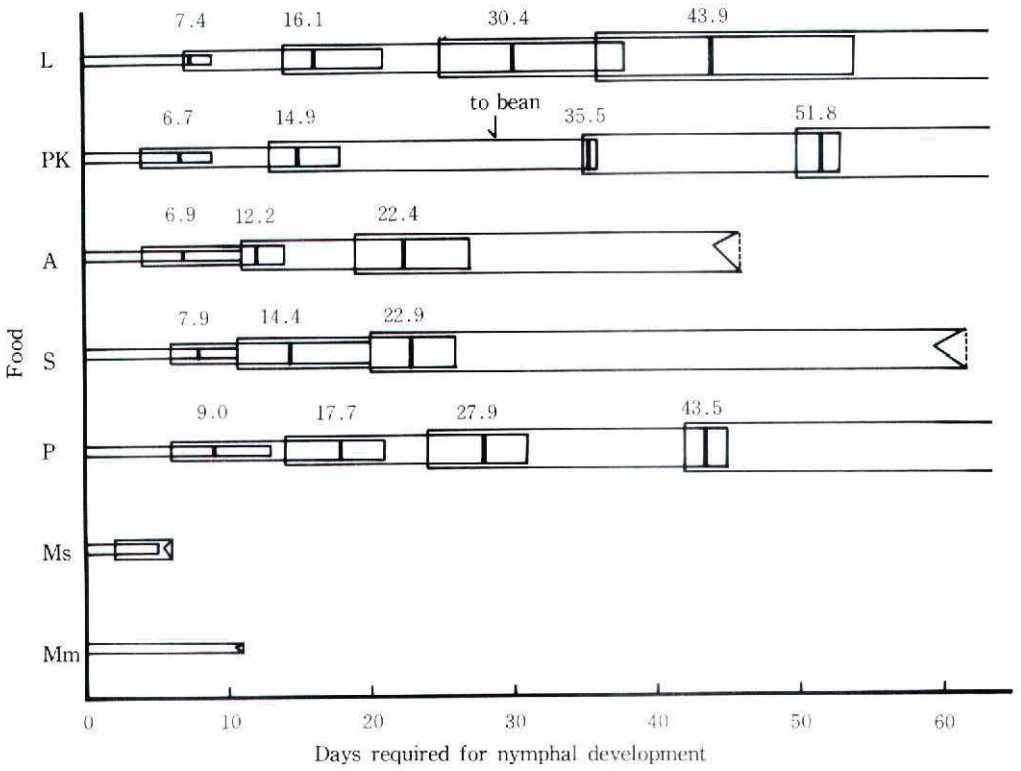

Fig. 6. Days required for development of *P. angulosa* nymphs fed several different foods. Black bars (number noted) show days average required to reach each instar or adult stage.

just like the pea-fed nymphs for which it required 9.0 days to the 3rd, 17.7 days to the 4th, 27.9 days to the 5th and 43.5 days to the adult stage. The rape bean-fed nymphs reached the 3rd instar in 6.7 days and the 4th in 14.9 days, earlier than the former two groups, but the time required for the 4th instar nymphal growth was longer: 37.5 days to the 5th and 51.8 days to the adult stage. The asparagus-fed and *S. commixta*-fed nymphs could not develop to the adult stage, although they grew very rapidly to the 5th instar (about 22 days).

Adult weight. Table 1 shows the weight attained 5 days after adult emergence. For both female and male the lilac-fed group was the heaviest, followed in decreasing order by the rape bean-fed group and the pea-fed group.

In the present study, it was found that lilac fruits were a suitable food plant in the nymphal stage of *P. angulosa*. Lilac trees seem to be an important host for this bug, because its eggs and the nymphs of various stages are often found on the leaves or fruits. Lilac fruits present on the trees from early July to early October are sure to support the nymphal development. Pea fruits can also be a good food plant for the nymphs and adults, though the mortality was high during the 5th instar perhaps because of the bad quality of pea fruits supplied. The nymphs and adults are often found feeding on pods, stems and leaves of peas in the field. Young and green rape fruits were a suitable food for younger nymphs, but it required a long time for the 4th instar nymphs fed with fruits of bad quality to grow: at that time, rape plants were

Table 1. Weight of *P. angulosa* adults 5 days after adult emergence

Food plant fed	Weight (mg)			
	Male	No.	Female	No.
Lilac fruit	122.9	5	132.2	2
Rape & kidney bean fruits	86.4	1	121.6	2
Pea fruit	47.0	1	96.4	1

withering so quickly that we could not get young and soft rape fruits. The growing period of rape plants may not be long enough to support all nymphal stages in the field. Therefore, the plants may be useful as a temporary food resource of the nymphs. Asparagus and *S. commixta* fruits were very good food plants for younger nymphs of *P. angulosa*, because the mortality was lower and the days up to the 5th instar were shorter. In the field, we confirmed that the 4th instar nymphs could develop to the adult stage on asparagus plants with fruits and *S. commixta* with fruits. (The reason why the 5th instar nymphs could not grow on the fruits to the adult stage in the laboratory experiment is not clear.) Therefore, *S. commixta* bearing fruits from June to December should be a good food plant in the field on which nymphal growth can be complete, whereas asparagus may only be useful as a temporary food plant because we have never found the eggs and the young nymphs before the 3rd instar on the plants in the field.

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エゾアオカメムシの幼虫生育に及ぼす各種食餌植物の影響

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摘　　要

エゾアオカメムシの幼虫生育にとって，インゲンマメの種子莢，エンドウマメの種子莢，小麦の穂，オオハナウドの種実およびライラックの種実が好適な食餌

植物であった。アスパラガスとナナカマドの実はすくなくとも比較的若い幼虫（野外では多分幼虫の全生育期間に対して）にとって，非常に良い食物であった。若い多汁なナタネの種子莢はまた幼虫生育にとって適した食物であろう。種実をつけていないアブラナ科植物，馬鈴薯，アルファルファおよびてん菜茎葉で幼虫を成虫まで生育せしめることはできなかった。